Soil Compaction Mapping Through Robot Exploration: A Study into Kriging Parameters

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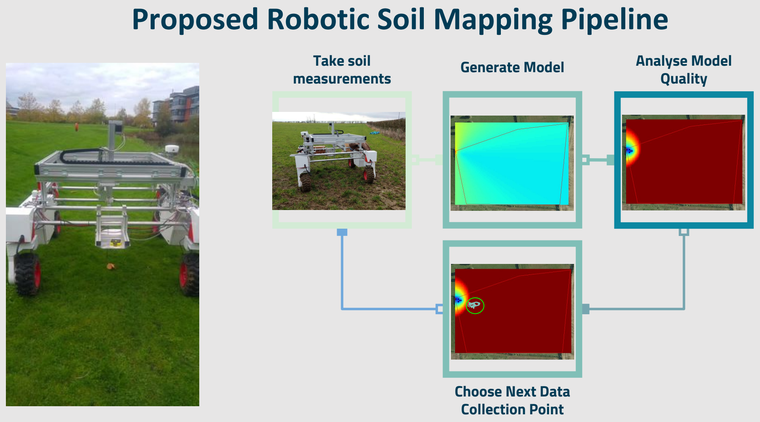
Motivation

- Soil condition mapping is a laborious and costly process.
- Soil measurements are taken at predefined locations, limiting the quality of the resulting maps.
- We propose the use of a robot equipped with a soil probe for automatic mapping of soil condition.
- Agricultural robots are equipped with GPS and computers, they can build and update soil models on-line using geo-statistical methods such as kriging.

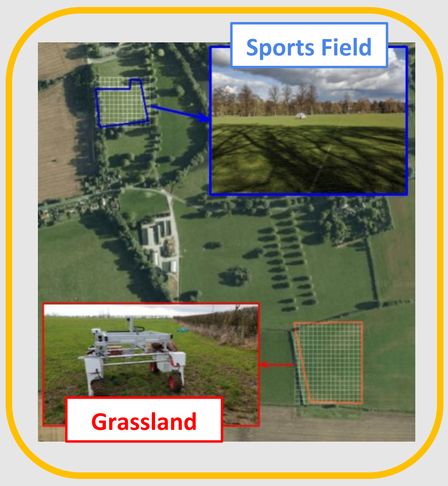
Typical Working Day for a Soil Scientist

Proposed Robotic Soil Mapping Pipeline



Soil Compaction Datasets

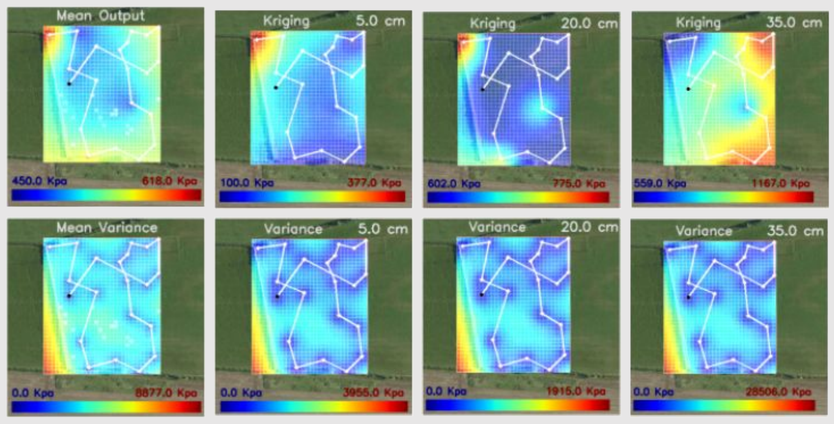
- We present a publicly available, high density, real-world soil compaction dataset comprising of geo-tagged soil compaction measurements collected by the robot from a sports field and a grass field used mainly for cattle pasture.
- Reference dataset obtained by a soil scientist for benchmarking and result comparison



Kriging-based Robotic Exploration

- We propose a mapping application using kriging variance as a reward function for robotic exploration.
- Model quality drives exploration, achieving more efficient data collection and better models.
- We take a close look at kriging and how its parameters affect robotic exploration

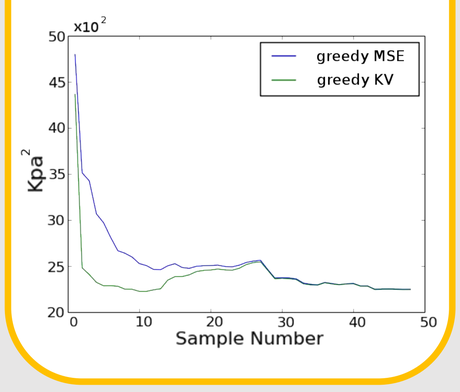
Multi-layer Soil Compaction Mapping
Kriging-Based Exploration Outcome



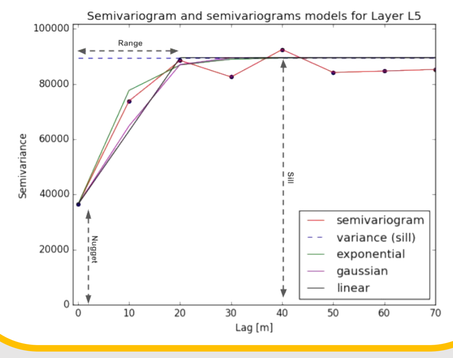
Kriging Variance as a Reward Function and Kriging Parameter Stability

- We demonstrate that reducing Kriging Variance reduces model error.
- We used surrogate models with the presented soil compaction datasets to analyse semivariogram parameter stability over the exploration.

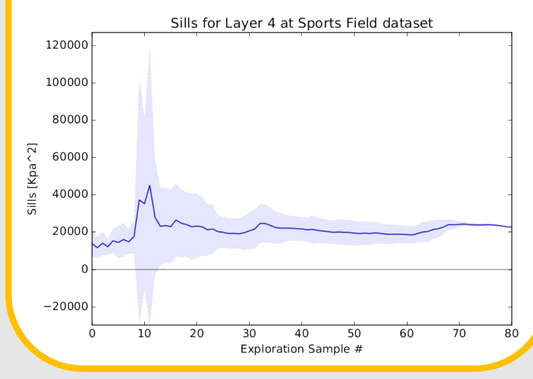
Kriging Variance VS Model Error



Semivariogram Parameters



Parameter Stability



Conclusions

- We show that kriging variance is an effective reward function for robotic exploration.
- We presents a study of the effects the kriging parameters have over the exploration outcome and how they tend to stabilise over time.
- We will use this knowledge to enhance future developments of our framework.